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ABSTRACT

This speech addressed the issue of educating minorities in the mathematical sciences. The speech is based on six regional workshops, and the national convocation of the Mathematical Sciences Foundation Board (MSEB). The introduction establishes the need for all students to become involved in the area of mathematics, and particularly minority students that have been historically disenfranchised in mathematics, if the United States is to successfully respond to future employment needs. This is followed by a challenge and a vision. The challenge is for America to not rely on drawing mathematicians from outside the country, but to develop the necessary human resources from within the country, especially from within the minority groups. Statistics examining the problem of underachievement and underrepresentation of minorities are examined and the impact of reports calling for mathematics education reform by the National Council of Teachers of Mathematics (NCTM) and the MSEB are discussed. A vision of mathematics education created around the NCTM's "Curriculum and Evaluation Standards," with teachers setting high expectations for minority students is then described. Students would be required to take mathematics every year until graduation. Colleges would create programs to strengthen and retain minority students in mathematics supported by professional organizations working collaboratively with funding agencies. Government agencies would invest more resources in teacher preparation and enhancement. The speech concludes with the assertion that America will ultimately benefit from providing quality mathematics education to minority students. (MDH)

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EQUITY AND EXCELLENCE IN THE MATHEMATICAL SCIENCES:

A CHALLENGE TO AMERICA

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Professor of Mathematics
University of the District of Columbia

Keynote Luncheon Address at the William Penn Foundation's Symposium on Mathematics, Science, and Engineering American Philosophical Society, October 9, 1992

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Keynote Luncheon Address at the William Penn Foundation's Symposium on Mathematics, Science, and Engineering American Philosophical Society, October 9, 1992

Beverly J. Anderson, Ph.D. - Professor of Mathematics, University of the District of Columbia

Introduction

I am honored to speak to you today on the topic, "Equity and Excellence in the Mathematical Sciences: A Challenge to America," because it is important for our country to begin to think of equity and excellence as terms that naturally go together. U.S. educational systems, especially, must understand the importance of giving all students, without regard to race, sex, ethnicity, creed, etc., an opportunity for excellence in mathematics and science, and this opportunity must be offered to them in an affirmative atmosphere.

In this address, I will share a vision I have for our country, a vision for our country regarding the maximum utilization of all of its citizens, especially with respect to educating minorities in the mathematical sciences. This vision was materialized in six regional workshops, and the national convocation of the Mathematical Sciences Education Board project, which I directed, entitled, "Making Mathematics Work for Minorities." This vision asserts the importance and necessity of all of America to work in concert for all students. It will not be enough to prepare some students in the area of mathematics, but it will be important to prepare all students for the workforce and for living in a

SE 053 481

technologically-driven society with a global economy.

Today, I will explore why it is economically in our own best interest to prepare our future leaders in science and mathematics, and why America must begin to look more seriously at minorities to fill the employment needs of this country. I will stress why America should find ways to reach and educate the growing population of minorities who have historically been disenfranchised in mathematics. I realize that this is an extraordinary challenge facing our country -- one with critical implications for the future well-being of the country. But the country, with your help, must meet this challenge to maintain its place as a leading nation in the world.

So today, I come to you with a challenge and a vision. Within that vision are possible actions that could be taken to reverse trends of underachievement and underrepresentation in the mathematical sciences of some groups of minorities.

The Challenge

A few months ago while visiting one of the pedagogical institutes in Russia, I heard a shocking pronouncement from a Russian professor. He said, "America understands that it is easier to buy a mathematician or scientist than to grow one." These words troubled me as I sat in his venue and heard the profound statement of this elder academician. His words to the mathematics education delegation with the Citizens Ambassador Program were deliberate. His belief, as I realized during my two-week stay there, was shared by many of his countrymen as they anticipate a "brain drain" of

professors and other scientists from Russia to fill job needs in the United States. Russia had painstakingly developed these professionals, and some of them have been and will continue to be lured to the United States mainly because of improved economic conditions for them in America. No longer would Russian professors have to earn wages of 3,000 rubles (about $30.00) per month to teach; they could come to America, teach in our most prestigious schools and earn at least one-hundred times that amount. Of course, for the strong nationalist professors, as this professor appeared to be, the offer to teach in America would be refused. There was a visible pleasure that he and several of the other professors like himself appeared to have in investing their energy in the future of their country by educating their citizenry.

After digesting the surprise of his assertion, I thought of how expensive it really is for America not to develop its own citizens to live and to make a living in today's world, and how much more expensive it will be in years to come. I thought about the expense of having nearly one-third of America's Black males, ages 16-29, involved in the penal system; of how expensive it is to finance the current welfare system, and indigent health care; of how expensive it is to finance violence in America -- the expense of the violence is passed down to each of us through insurance premiums and hospital care, and I can go on and on. I thought of how expensive it really is for a large group of citizens to depend on American systems, rather than to contribute in a meaningful way to American society and economy. I thought America must not and

cannot be perceived as a rich country with an insufficient supply of human resources. That somehow suggest a threat to our national security. I thought America must come to see that it is and will continue to be considerably more expensive to buy rather than to grow its own mathematicians and scientists, and other functional and productive individuals.

Plato and other philosophers acknowledged centuries ago that mathematics is the foundation of the sciences. In more recent times Lucy Seels has found in her research that mathematics is the invisible filter -- students who do not acquire a sufficient background in mathematics prior to college are virtually eliminated from an inordinate number of careers in the physical sciences and engineering, as well as those in the social sciences and psychology (Seels, 1980).

The Department of Labor has projected that 21,000,000 new jobs will be created from 1986-2000. These new jobs, even those not requiring a college education, will require basic skills in mathematics and in the ability to reason. More than half of these jobs will require some education beyond high school, and almost one-third will be filled by college graduates. Jobs requiring mathematical skills are growing at nearly double the rate of overall employment. These jobs have traditionally gone to White males. However, by the year 2000, there will not be enough White males trained in mathematics to satisfy workforce demands.

With more and more jobs requiring increased mathematics skills and literacy, we must help minorities learn and understand the

connection between mathematics and career options. Simply put, the more mathematics one knows, the more money one can earn. It has been reported that those who take more mathematics in high school and/or college earn substantially more during the first decade of their occupational careers than do others in the job market; this relationship is particularly strong for men (Adelman & Absalom, 1988).

Hence, it is incumbent upon the country and particularly the current mathematics and science communities to take corrective measures to make mathematics and science work for the growing population of minorities that have been disenfranchised in these areas. To do so, we must take a close look at some statistics on minorities in America, and put the problem of underachievement and underrepresentation in perspective. Some of these statistics will bring to bear some of the inequities that exist in mathematics education in U.S. schools and institutions of higher learning. In presenting these statistics, I will focus mainly on Blacks and Hispanics, as they comprise nearly 90% of the minorities in this country.

- 1990 Census data show that Blacks and Hispanics make up approximately 21% of the U.S. population. From 1980 to 1990, the White population grew 6%, the Black population grew 13.2%, and the Hispanic population grew 53%. (U.S. Department of Commerce, 1991)
- In 1989, Blacks and Hispanics earned approximately 8% of

the bachelor's degrees, 3.6% of the master's degrees, and 3% of the Ph.D.'s in science and engineering. (Commission on Professionals in Science and Technology (CPST), 1991)

- In 1989, 8.6% of all bachelor's degrees; 7% of the master's degrees and 4.8% of the Ph.Ds. were awarded to Blacks and Hispanics. (CPST, 1991)
- Fewer than 30% of all colleges and universities awarding bachelor's degrees in mathematics and the physical sciences, and fewer than 20% awarding degrees at the master's and doctoral levels conferred such degrees on Blacks.
- Approximately 6.6% of the faculty in U.S. colleges and universities consists of Blacks and Hispanics, and approximately 5.6% of the faculty in the mathematical sciences are of these ethnic groups. (CPST, 1991)
- In 1991, Blacks and Hispanics made up approximately 17.6% of the workforce but only 7% of the employed scientists and engineers in America. (Department of Labor, 1992)
- 1990 figures report that at least 53% of 17 year-old Blacks and Hispanics say that their highest level of mathematics course work was at or below Algebra I -- compared with 59% of White 17 year-old students who said that their highest course was Algebra II or above. (United States Department of Education, 1991)
- Black students score nearly 90 points below the average score for all students, and Hispanic students score 70

points below the average, nationally, on the mathematics section of the SAT. (Admission Testing Program of the College Entrance Examination Board, 1991)

- 15% of all Black students and 36% of all Hispanic students, nationally, drop out of high school.
- Twenty-two of the 25 largest city school districts in the nation are predominately minority. (QEM, 1990)
- Blacks and Hispanics make up approximately 11% of the teaching force in the U.S., but only 6% of the high school teachers of mathematics in grades 10-12. In 1989, for every 439 students enrolled in a teacher education program, nationally, there were 28 (6.4%) Blacks and 11 (2.5%) Hispanics. (AACTE, 1991)
- According to a July, 1992 press release from the Children's Defense Fund, approximately 39.8 percent of all Black children, 32.2 percent of all Hispanic children, and 12.5 percent of all White children live in poverty. In 1991, Sam Husk, Executive Director of the Council of Great City Schools, reported that approximately 60% of the children in urban schools live in poverty.
- Nearly 1/2 of all poor children (47%) score in the bottom quarter on achievement tests, more than twice the rate of non-poor children (19%). (Department of Education, 1990)
- Low achievers are five times more likely than other students to become dependent on welfare ("Schools That

Work," Department of Education).

- In 1989, America ranked fourth (4th) in the world relative to the amount of money spent on education per student ($3,773), yet we ranked thirteenth (13th) in the world among industrialized nations in mathematics achievement.

By the year 2000, when roughly one-third of the nation will be minority, 50% of today's school teachers will have reached retirement age, and it has been projected that one-third of the professoriate will have retired. The pipeline in teacher education programs suggest that we will have an insufficient pool to replace the aging faculty, and the proportion of minority elementary and secondary school students is far greater than that of the future teaching force. Also, since Blacks and Hispanics comprise approximately 5.6% of the current professoriate in the mathematical sciences, the Ph.D. pipeline beginning with the bachelor's degrees in the mathematical sciences suggests that this trend will not be reversed in the near future.

All segments of society agree that the United States must address some of the social problems impacting education and must improve the quality of its educational system to remain competitive in the world economy. The U.S. governors have provided the leadership for a national reform movement in education by establishing six goals for education to be attained by the year 2000, and by establishing two communities: National Education Goals Panel and National Assessment Panel to develop plans to facilitate

the attainment of these goals. The panel on goals has issued an action plan for achieving the six goals by the year 2000. The panel on assessment is in the process of designing assessment packages for grades 4, 8, and 12 in five subject areas-- English, mathematics, science, history, and geography -- that will be used by states to provide a report card on the effectiveness of their educational programs.

In an effort to improve the quality of mathematics education, seven major reports have appeared in planned sequence, from 1989-91, calling for fundamental changes in both school (elementary and secondary) and college mathematics curricula and instruction. These reports consist of:

- "Everybody Counts - A Report to the Nation on the Future of Mathematics Education," Mathematical Sciences Education Board (MSEB), January, 1989.
- "Reshaping School Mathematics: A Philosophy and Framework for Curriculum," MSEB, January, 1990.
- "The Curriculum and Evaluation Standards for School Mathematics," National Council of Teachers of Mathematics (NCTM), 1990.
- "On the Shoulders of Giants: New Approaches to Numeracy" MSEB, September, 1990.
- "Making Mathematics Work for Minorities: Framework for a National Action Plan, 1990-2000" MSEB, December, 1990.
- "Professional Standards for Teaching Mathematics," NCTM, March, 1991

- "Moving Beyond Myths: Revitalizing Undergraduate Mathematics: Final Report of Project MS2000" MSEB, April, 1991.

These reports, especially the "Curriculum and Evaluation Standards for School Mathematics," are having a profound impact on mathematics education by inspiring and motivating schools and colleges around the nation to re-examine their mathematics programs, and to work toward full compliance with the recommendations. They challenge school teachers to create classroom environments in which more students can thrive. They challenge school teachers to use innovative, interesting materials in the mathematics classroom -- material that is challenging and meaningful, and which not only improves computational skills, but also enhances reasoning skills. They challenge teachers to freely use technological tools to enhance student learning. They also challenge teachers to set higher expectations for minority students, specifically Blacks, Hispanics and American Indians.

Our challenge, then, is to use these national goals and use these major reports on reform in mathematics education at all levels to be more inclusive in whom we educate mathematically. Bearing in mind the growing social problems, including the impact of poverty, we must figure out how we are going to educate minorities in the mathematical sciences as we set higher goals and expectations for them to achieve. The reports are calling for the country to do so, and we must meet this challenge. We must launch more and more underrepresented minorities onto the "success

pathway," and we must act now.

The Vision

I see all segments of the population supporting schools and colleges to increase minority participation in mathematics and science. I see schools having strong programs in mathematics, created around NCTM's "Curriculum and Evaluation Standards for School Mathematics." I see teachers of mathematics in these schools enthusiastically involved in in-service training on the use of technological tools in the mathematics classroom; on preparing lessons in probability and statistics for students at all levels; on preparing meaningful graphic and tabular data for students at all levels, and on how to encourage minority students to believe that they can and must learn mathematics. I see parents supporting strong mathematics programs in the schools and volunteering services to enhance those programs. I see parents believing that their children can and must perform well in mathematics and encouraging their children to do so.

I see teachers of mathematics at all levels confidently analyzing, discussing, and using quantitative data, understanding the connections between mathematics and other disciplines, and using technological tools to enhance instruction. Hence, I see more students having an opportunity to be competitive at the national and international levels, and more students and teachers exposed to a learning environment that will make it possible for them to become prepared to contribute to the society of the 21st Century.

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I see teachers setting high expectations for minority students in mathematics, and I see programs like the one developed by the famous mathematics teacher, Jaime Escalante, in Los Angeles, springing up all over the country. Escalante believed that Hispanic students could learn Calculus while in high school and set out to prove this to his peers at Garfield High School and to the community, in spite of the apparent disbelief of some faculty in the school's mathematics department, and parents in the community. Escalante and a team of teachers set high expectations for these students, and gave good instruction and challenging materials in mathematics. The result was that the students lived up to the expectations, and year after year an unusually high number of these students passed the AP Calculus examination prepared by the College Board.

I see students taking mathematics every year while in high school, and some of them working after school and on week-ends with teachers, study groups and/or with community volunteers to improve their skills and understanding of the powerful subject matter. I see students actively engaged in mathematics clubs and problem solving teams.

I see colleges and universities across the country, especially majority institutions, creating an affirmative atmosphere for minority students. I see them developing support programs to strengthen, and thus retain, underrepresented minority students at their universities. These programs can also help minority students create for themselves a community of academic friends with whom to

study. One such program is the well structured, well documented Mathematics Workshop at the University of California/Berkeley. Many of you may already know that Black students engaged in the Mathematics Workshop, developed by Dr. Uri Treisman, outperformed the White students in Calculus I on the final departmental examination in at least one semester. Of importance here is not so much that they outperformed the white students at Berkeley, but that they could demonstrate on a written measure that they learned Calculus I well. Their performance level in Calculus I has remained relatively high throughout the course of the project. Workshop students, we should note, were given challenging material and were led to believe that they could be successful in their calculus class. They were not given remediation support services. Of note, also, is that this program was supported by the entire university, thus sending a message to the academic communities across the country that minority student success efforts cannot be invested in only one person or one office.

I see departments of mathematics across the country fostering a different perception of mathematics and the mathematics major. Dr. Clarence Stephens, the creator of a successful undergraduate mathematics program at State University of New York (SUNY)-Potsdam, where approximately 24% of the bachelor's degrees were in mathematics, stated: "We focus on the human factor, to change students' perception that mathematics is an almost impossible subject for students to learn and that only the most gifted can be expected to achieve any degree of success." Dr. Stevens asserts

that students want to learn mathematics because of the supportive environment at SUNY-Potsdam.

I see more and more professional organizations working collaboratively with funding agencies to encourage organization members to develop meaningful programs to increase minority participation in mathematics and science. The Mathematical Association of America (MAA) received a grant from The Carnegie Corporation of New York to encourage the creation of academic intervention programs for minority school students on college and university campuses in the U.S. In 1992, MAA received a grant in the amount of $703,000 from the National Science Foundation to network the existing intervention projects in mathematics and the ones encouraged from funds from The Carnegie Foundation. Todate, MAA has provided planning grants to twenty-four colleges and universities to facilitate the development of their intervention programs, and has presented thirteen (13) regional workshops to MAA members interested in developing academic intervention programs in mathematics on their campuses. Hence, I see colleges and universities across the country developing meaningful academic intervention programs in the mathematical sciences for school students to stimulate minority interest in the mathematical sciences and improve their skills. I see these colleges and universities becoming more aware of the mathematics potential in minorities. As a result, I see more minorities taking majors in the mathematical sciences, and receiving degrees at the bachelor's, master's and doctoral levels from an expanded list of colleges and

universities in the U.S. And I also see more underrepresented minorities seeking careers as school teachers and college professors of mathematics.

One of the most rewarding experiences I have had as a professor of mathematics was the opportunity to plan and implement academic intervention programs in mathematics for school students and their teachers designed to stimulate their interest in the subject matter and broaden their knowledge.

I see two-year institutions, where approximately 50% of the minority students in undergraduate institutions are enrolled, setting articulation programs with four-year institutions, so that more than 10%-15% of the minority students will transfer in to the baccalaureate granting institutions. A successful articulation program currently exists between Austin Community College and the University of Texas.

I see more and more private philanthropic organizations, such as the William Penn Foundation, investing large sums of money to address the problem of underrepresentation of minorities in the mathematical sciences. Their Minorities in Higher Education Initiative, which focuses on increasing the number of Black and Hispanic students who graduate with degrees in mathematics, science and engineering, and encourages more of these students to prepare for the professoriate, is exemplary in reversing trends of underrepresentation.

And finally, I see government agencies, such as the National Science Foundation, investing more and more resources in teacher

preparation and enhancement, and in developing innovative undergraduate and graduate programs to prepare teachers to maximize emerging talent from the "new face of America."

Thus, over the next few years all of us must take significant steps to keep minorities in school and focused on the appropriate academic areas so that they will meet the workforce demands in the United States. Hence, it is no longer just an educational issue, but rather a serious economic issue as we begin to prepare more of our citizens to solve the problems in this country and to contribute to our fundamental systems, such as social security.

Adequate and responsible education must be provided throughout the education pipeline to develop a trained citizenry. Only then will the "new face of America" be able to acquire undergraduate and graduate degrees in the mathematical sciences from a myriad of colleges and universities in the United States. Only then will the "new face of America" enter our schools of teacher and graduate education. Only then will the "new face of America" replace our aging faculties at the school, college and university levels. Only then will the "new face of America" perform the research in our laboratories to maintain our competitiveness with the rest of the world. Only then will the "new face of America" provide for our national security, and be prepared to live and to make a living in the society of the 21st Century. Adequate and responsible education will make it possible for a larger than ever proportion of the population of minorities to contribute to the nation's economy rather than depend upon it

for support. Adequate and responsible education will ensure a reversal of trends of underachievement and underrepresentation of Blacks and Hispanics in the mathematical sciences. The teacher of mathematics and the professor of mathematics are critical to the solution of the problem, as their investment in students will indeed be an investment in America, and will determine the extent to which this country will be self-sufficient in the years to come.

Clearly, Blacks and Hispanics have achieved excellence in the mathematical sciences when their teachers and professors have set high expectations for them to achieve, and when they believe that minorities can and must perform well in mathematics. These teachers have given 100% of their time and effort to facilitate the success of their students. Consequently, their students have indeed achieved in spite of the odds and insurmountable obstacles of life.

No longer can we allow the growing minority population in the United States to be ill-equipped to handle many of the jobs needed in a technological society. No longer can we discourage minorities from pursuing mathematics, the all-encompassing hub of the sciences, which Galileo called the "alphabet with which God has written the earth." No longer can we allow anyone to say that America chooses to buy its scientists and mathematicians than to grow its own. So you, the future leaders of the mathematical sciences, must continue to make it clear to America that it is indeed more expensive to buy a mathematician or a scientist than to grow one. Ultimately, the beneficiary of America's investment to

provide quality education to minorities and to all of its citizens will indeed be America.

Thank you.

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